

I claim:

- 1     1.     An imaging assembly comprising:  
2             an electronic imager 14 having an image plane and  
3             an objective lens 12 having a focal length  $f_0$  for receiving light from an object  
4     and for forming an image of the object on the image plane, the objective lens  
5     comprising:  
6             a lens group having an object surface facing the object and an image  
7             surface, the lens group having at least a single lens element and a focal length  
8              $f_1 > 0$ ,  
9             a middle lens element having an object surface and an image surface, the  
10            object surface being a concave surface facing the lens group image surface, the  
11            middle lens element image surface being a convex surface, and  
12            a final lens element having an object and an image surface and a positive  
13     power, the object surface facing the middle lens element image surface, the object  
14     surface facing the image plane, the lens group, middle lens element and final lens  
15     elements being shaped and coaxially positioned on an optical axis to obtain a ratio of  
16      $f_1/f_0$  such that  $0.5 < f_1/f_0 < 2.0$ .
2.     The imaging assembly of claim 1 wherein the lens group is a single lens element  
with positive power.
3.     The imaging assembly of claim 1 wherein the lens group is a cemented doublet  
lens with positive power.
4.     The imaging assembly of claim 1 wherein the lens group is a triplet lens with  
positive power.
5.     The imaging assembly of claim 1 wherein the lens elements in the lens group are  
made of glass materials.

6. The imaging assembly of claim 1 wherein the object surface of the middle lens element is aspherical.
7. The imaging assembly of claim 1 wherein the image surface of the middle lens element is aspherical.
8. The imaging assembly of claim 1 wherein the final lens element is made of glass material.
9. The imaging assembly of claim 1 wherein the final lens element has a substantially flat image surface.
10. The imaging assembly of claim 1 wherein the final lens element image surface is coated with an IR cut-off interference coating.

11. The imaging assembly of claim 1 wherein the lens group further comprises a single lens element, the lens group, the middle lens element and the final lens element having surfaces shaped to conform to the prescription of the following Table 1 and Table 2 as follows:

Table 1						
Surface	SURFACE DATA SUMMARY (Singlet 34a)					
	Surface Number	Type	Radius	Thickness	Nd	Abbe
1	OBJECT,30	STANDARD	Infinity	Infinity		
2	40a	STANDARD	1.64	1.49	1.618	63.4
3	a (STO)	STANDARD	3.29	0.64		
4	44	EVENASPH	-2.28	1.34	1.689	31.2
5	46	EVENASPH	-5.68	0.10		
6	48	STANDARD	5.88	1.22	1.801	44.3
7	50	STANDARD	8582.37	1.21		
8		STANDARD	Infinity			

Table 2		
Aspheric coefficients for surfaces of the middle lens element 36		
Row	Surface 44 of the middle lens element 36 Evenasph Lens	
1	D	-0.079282116
2	E	-0.19307826
3	F	0.48564859
4	G	-0.71896107
5	H	0
6	I	0
	Surface 46 of the middle lens element 36 Evenasph Lens	
1	D	-0.002466236
2	E	-0.010260173
3	F	0.002754689
4	G	-0.000681387
5	H	0
6	I	0

12. The imaging assembly of claim 1 wherein the lens group has two elements, the middle lens element having an aspherical surface and the final lens elements being shaped to conform to the prescription of the following Table 3 and Table 4 as follows:

Table 3						
SURFACE DATA SUMMARY (doublet 34b)						
Row	Surface	Type	Radius	Thickness	Index	Abbe
1	OBJ 30	STANDARD	Infinity	Infinity		
2	40b	STANDARD	1.715843	1.423295	1.641	60.1
3	41a	STANDARD	-3.767582	0.325250	1.673	32.2
4	42b & STOP	STANDARD	3.227809	0.540690		
5	34	EVENASPH	-2.885900	1.217885	1.491	57.4
6	36	EVENASPH	7.761245	0.100000		
7	38	STANDARD	7.818255	1.392907	1.855	36.6
8	40	STANDARD	-7.818260	0.999993		
9	IMA	STANDARD	Infinity			

Table 4		
Aspheric coefficients for surfaces of the middle lens element 36		
Row	Surface 44 of the middle lens element 36 Evenasph Lens	
1	D	-0.15545497
2	E	-0.1693017
3	F	0.58931065
4	G	-1.0012036
5	H	
6	I	
	Surface 46 of the middle lens element 36 Evenasph Lens	
1	D	-0.026801269
2	E	0.000946834
3	F	-0.000221566
4	G	-7.01E-05
5	H	
6	I	

13. The imaging assembly of claim 1 wherein the lens group elements, the middle lens element and the final lens element are shaped to conform to the prescription of the following Table 5 as follows:

Table 5						
SURFACE DATA SUMMARY (triplet 34c)						
Row	Surface Number	Type	Radius	Thickness	Index	Abbe
1	OBJ	STANDARD	Infinity	Infinity		
2	40c	STANDARD	2.25801	1.058656	1.803	46.7
3	41b	STANDARD	7.551701	0.1086743		
4	41c STOP	STANDARD	-22.14754	0.5789873	1.785	25.8
5	41d	STANDARD	3.114468	0.05402182		
6	41e	STANDARD	3.603306	1.100749	1.803	46.7
7	42c	STANDARD	-8.174966	0.7061964		
8	44	STANDARD	-1.275432	1.004195	1.847	23.8
9	46	STANDARD	-2.559828	0.0485716		
10	48	STANDARD	9.962559	1.358772	1.836	42.3
11	50	STANDARD	-40.95514	0.984538		
12	IMA	STANDARD	Infinity			

1    14.    An imaging assembly comprising:  
2            an electronic imager 14 having an image plane and  
3            an objective lens with a focal length  $f_0$ , the objective lens having an object  
4    surface for receiving light from an object and for forming an image on the image plane,  
5    the objective lens having,  
6            a lens group with focal length  $f_1 > 0$ , the lens group having an object  
7    surface facing the object and an image surface,  
8            a middle lens element having an object surface and an image surface, the  
9    object surface being a concave surface facing the lens group image surface, the image  
10   surface being convex surface, and  
11           a final lens element having an object surface and an image surface and a  
12   positive power, the object surface facing the middle lens element image surface,  
13           the lens group, middle lens and final lens elements being coaxially aligned and  
14   positioned on an optical axis normal to the image plane, the distance from the lens  
15   group object surface to the image plane being  $TT$  (the lens height), the lens elements  
16   being shaped and positioned such that  $TT/DI < 1.3$ .

15.    The imaging assembly of claim 14 wherein the ratio of  $f_1$  to  $f_0$  is in a range such  
that  $0.5 < f_1/f_0 < 2.0$ .

16.    The imaging assembly of claim 14 wherein the lens group is a single lens  
element with positive power.

17.    The imaging assembly of claim 14 wherein the lens group is a cemented doublet  
lens with positive power.

18.    The imaging assembly of claim 14 wherein the lens group is a triplet lens with  
positive power.

19. The imaging assembly of claim 14 wherein the object surface of the middle lens element is aspherical.
20. The imaging assembly of claim 14 wherein the image surface of the middle lens element is aspherical.
21. The imaging assembly of claim 14 wherein the lens elements in the lens group are made of glass material.
22. The imaging assembly of claim 14 wherein the final lens element is made of glass material.
23. The imaging assembly of claim 14 wherein the final lens element has a substantially flat image surface.
24. The imaging assembly of claim 14 wherein the final lens element image surface is coated with an IR cut-off interference coating.

1    25.    An imaging assembly for use in a digital camera or cell phone having a body,  
2    the imaging assembly comprising:  
3            an electronic imager coupled to the body, said electronic imager having an active  
4    surface, an image plane being formed on the active surface with a maximum effective  
5    dimension DI,  
6            an imaging assembly having a focal length  $f_0$  comprising:  
7    a lens group having at least one lens element, the lens group having a focal length  $f_1 > 0$ ,  
8            a middle lens element having an object surface and an image surface, the object  
9    surface being a concave surface facing the lens group image surface, the middle lens  
10   image surface being convex surface, and  
11            a final lens element having an object surface and an image surface, the final lens  
12   element having a positive power, the object surface facing the middle lens element  
13   image surface,  
14            the lens group, the middle lens and the final lens elements being coaxially  
15   aligned and positioned on an optical axis normal to the image plane, the distance from  
16   the lens group object surface to the image plane being the lens height (TT) , the lens  
17   group, the middle lens and the final lens elements being shaped and positioned such that  
18    $0.5 < f_1/f_0 < 2.0$ , and  $TT/DI < 1.3$ .

26.    The imaging assembly of claim 25 wherein the lens group is a single lens  
element with positive power.

27.    The imaging assembly of claim 25 wherein the lens group is a cemented  
doublet lens with positive power.



28. The imaging assembly of claim 25 wherein the lens group is a triplet lens with positive power.
29. The imaging assembly of claim 25 wherein the lens elements in the lens group are made of glass materials.
30. The imaging assembly of claim 25 wherein the object surface of the middle lens element is aspherical.
31. The imaging assembly of claim 25 wherein the image surface of the middle lens element is aspherical.
32. The imaging assembly of claim 25 wherein the final lens element is made of glass material.
33. The imaging assembly of claim 25 wherein the final lens element image surface is substantially flat.
34. The imaging assembly of claim 25 wherein the final lens element image surface is coated with an IR cut-off interference coating.